SenseLink™

End-Point Controller

Addendum

MKS Instruments, Inc.
Control & Information Technology Products Group
3350 Scott Blvd Bldg 4
Santa Clara, CA 95054

Main: 408.235.7620
Fax: 408.235.7625

SenseLink™ Version 1.1.6 / P004
Manual Revision A
10/04

Copyright

3350 Scott Blvd Bldg 4

Santa Clara, CA 95054

Preface

About this addendum

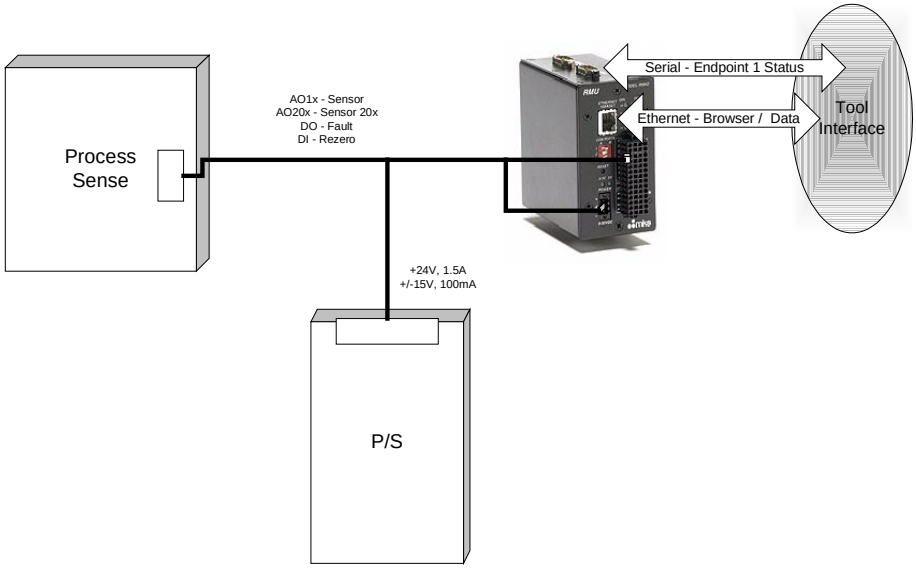
This addendum is designed to serve as a guideline to the installation, set up, operation and basic maintenance of the Remote Monitoring Unit with the SenseLink™ End-Point Control Interface features. The information contained within this manual, including product specifications, is subject to change without notice. Please observe all safety precautions and use appropriate procedures when handling the SenseLink™ RMU product and its related software.

Table of Contents

1 Overview and Installation

The Remote Monitoring Unit (RMU) with the SenseLink™ End-Point Control Interface is a data collection, monitoring and control device for managing End-Point of an MKS Process Sense™ sensor. The RMU provides self-contained logic control, communication and storage of End-Point sensor data.

All configuration of the RMU can be done via the web based user interface. After the initial setup, these units collect, store and analyze your data. End-Point calls are communicated via a serial communication interface to the Tool Module Controller. The data is viewed and/or downloaded through a standard web browser.



1.1 Wiring Diagram

The following connections are required to run this End-Point system with RMU and Process Sense.

Connection Points

	Cable	Process Sense		RMU		Power Supply
Ref	**Signal**	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**
1	SENSOR 1X	SIGNAL 1X	1	AI1+	IO1	
2	SENSOR 20X	SIGNAL 20X	2	AI2+	IO3	
3	REZERO	CAL RETURN	4	DO01	IO22	
4	-15VDC	-15VDC SUPPLY	6			-15VDC
5	+15VDC	+15VDC SUPPLY	7			+15VDC
6	+24VDC	24 VDC SUPPLY	8	+, 24V	PW1	24VDC
7	SENSOR COM	SIGNAL REF	9	AI1- / AI2-	IO2,IO4	
8	FAULT	FAULT	10	DIN1+	IO13	
9	15VDC COM	15 VDC COMMON	13			15VDCCOM
10	24VDC COM	24 VDC COMMON	15	-, DO01C	PW3, IO21	24VCOM
11	AI3 JUMPER			AI3+, AI3-	IO5, IO6	
12	AI4 JUMPER			AI4+, AI4-	IO7, IO8	
13	SHIELD		HOOD			

Connectors

Ref	Connector	Description	Part Number	Manufacturer	Qty
1	Process Sense	D-sub 15 Female			1
2	RMU PW	Pluggable, clamp terminal, 3 pole	1691120000	Weidmuller	1
3	RMU - IO	Pluggable, clamp terminal, 28 pole	1748280000	Weidmuller	1
4	Power Supply	ferrule			5

RMU I/O Wiring

The RMU has a 28-pin I/O Terminal Block. Each I/O configuration has unique pin assignments, which are shown in the following tables. The incoming power from the Power Terminal Block is available as a reference voltage on the I/O Terminal Block.

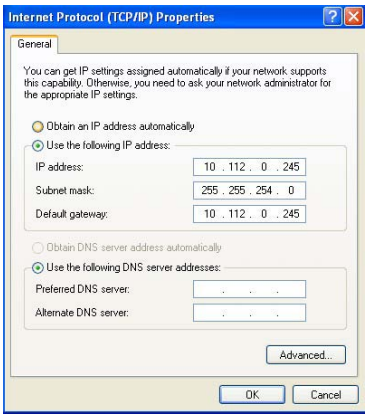
I/O Terminal Block for (4) AI – Differential, (4) DI - Active Low

PIN	LABEL	DESCRIPTION		PIN	LABEL	DESCRIPTION
28	O4	Digital Output 4 (relay contact N.O.)		27	04C	Digital Output 4 (relay common)
26	O3	Digital Output 3 (relay contact N.O.)		25	O3C	Digital Output 3 (relay common)
24	O2	Digital Output 2 (relay contact N.O.)		23	O2C	Digital Output 2 (relay common)
22	O1	Digital Output 1 (relay contact N.O.)		21	O1C	Digital Output 1 (relay common)
20	I4(-)	+24VDC common		19	I4(+)	Digital Input 4 (sinking, active low)
18	I3(-)	+24VDC common		17	I3(+)	Digital Input 3 (sinking, active low)
16	I2(-)	+24VDC common		15	I2(+)	Digital Input 2 (sinking, active low)
14	I1(-)	+24VDC common		13	I1(+)	Digital Input 1 (sinking, active low)
12	COM	+24VDC common		11	24V	+24VDC
10	COM	+24VDC common		9	24V	+24VDC
8	AI4(-)	Analog Input 4 (negative input)		7	AI4(+)	Analog Input 4 (positive input)
6	AI3(-)	Analog Input 3 (negative input)		5	AI3(+)	Analog Input 3 (positive input)
4	AI2(-)	Analog Input 2 (negative input)		3	AI2(+)	Analog Input 2 (positive input)
2	AI1(-)	Analog Input 1 (negative input)		1	AI1(+)	Analog Input 1 (positive input)

2 Quick-Start for End-Point Control

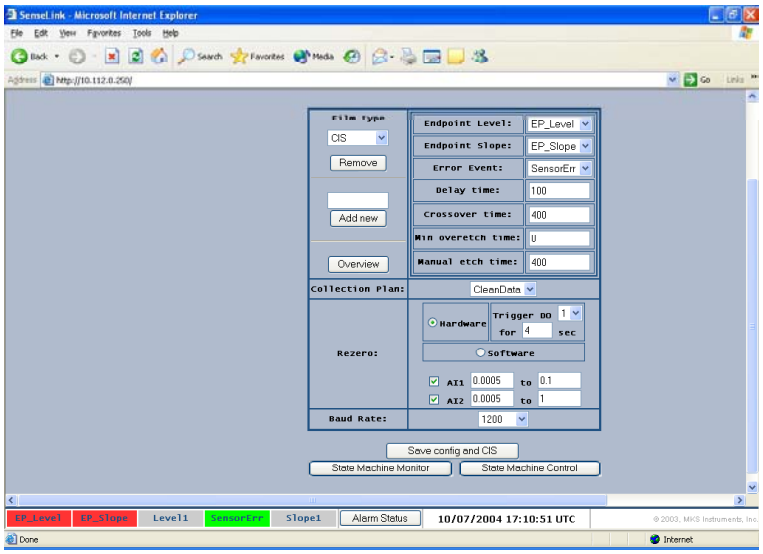
1. Power up RMU by attaching power connector with 24VDC source, 500mA.
2. Attach network crossover cable to RMU and your PC.
3. Modify your network TCP/IP settings to match the following:

   PC IP Address: **192.168.1.4**
   PC Netmask: 255.255.255.0



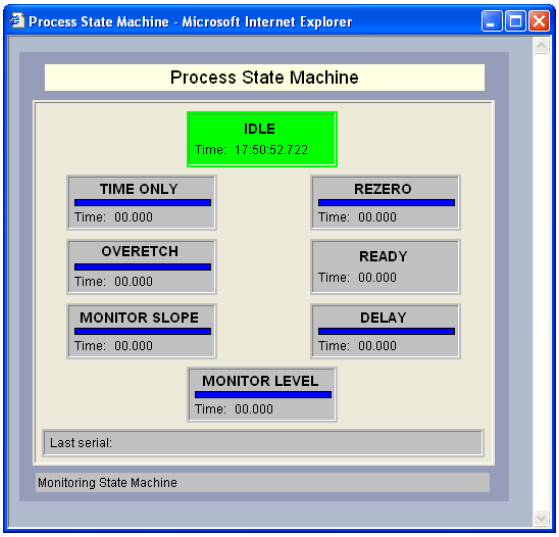
4. Start up a web browser and point it to **192.168.1.5.** You will see the main SenseLinkTM configuration page, showing all analog and digital inputs. There is slight delay as the unit transfers items to your local browser.

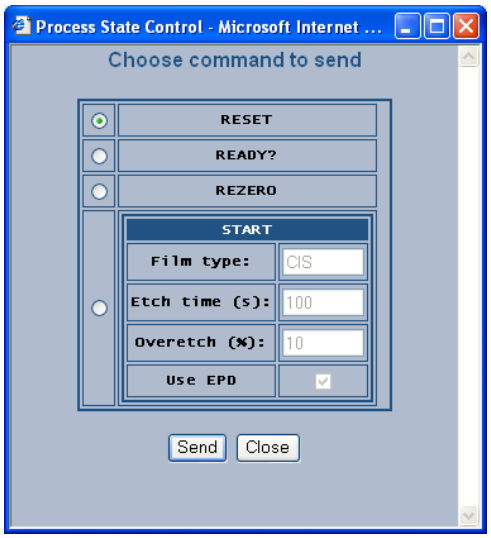
5. Click on the Control tab, to see the main settings for End-Point.



6. Click on State Machine Monitor, to see the running state of the End-Point logic. As you run a Clean, the state machine will cycle through each step, highlight in green, and show an elapsed time indicator bar. Last serial command received from controller is displayed on bottom toolbar.

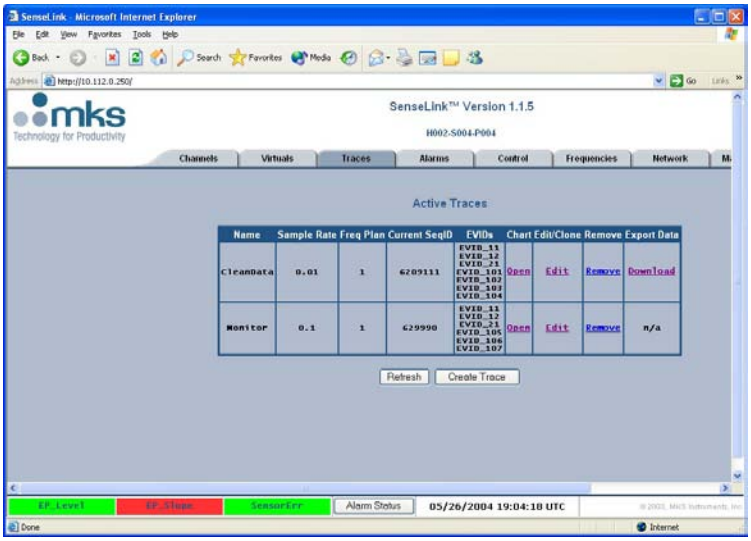
   If you are not connected to the Tool, you can simulate these commands by using the State Machine Control panel.



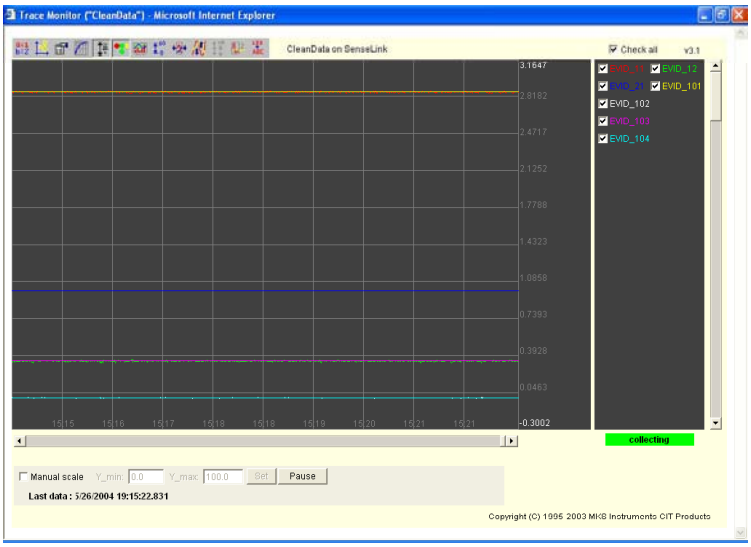


7. Click on the Alarms tab to see the End-Point logic definitions. These can easily be changed by clicking on Edit.

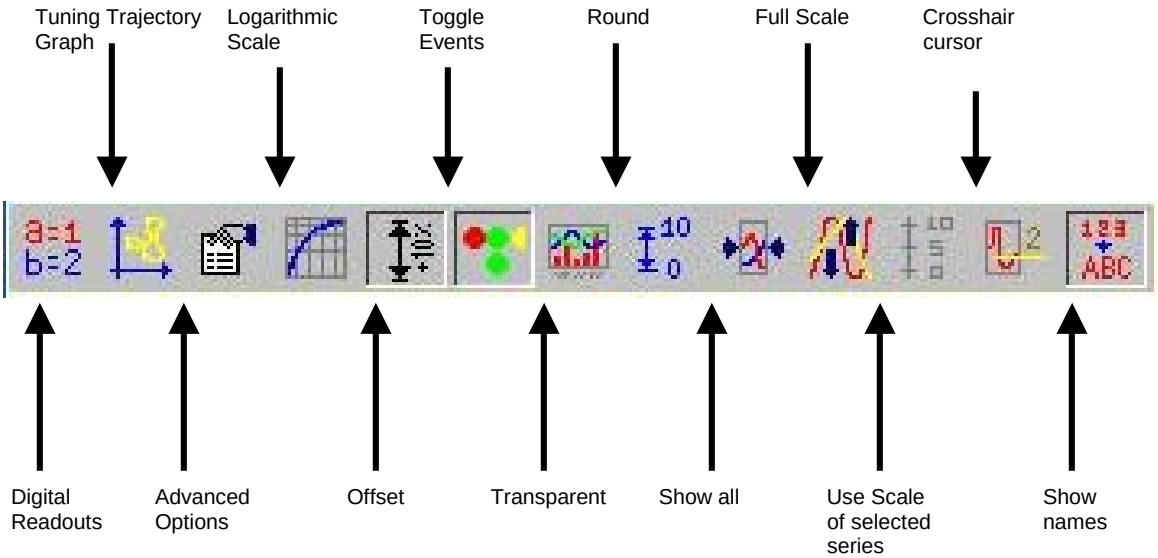
8. Click on Traces tab to see the data collection plans. Go to the second data collection plan, labeled Monitor. Click on Open under the Chart icon



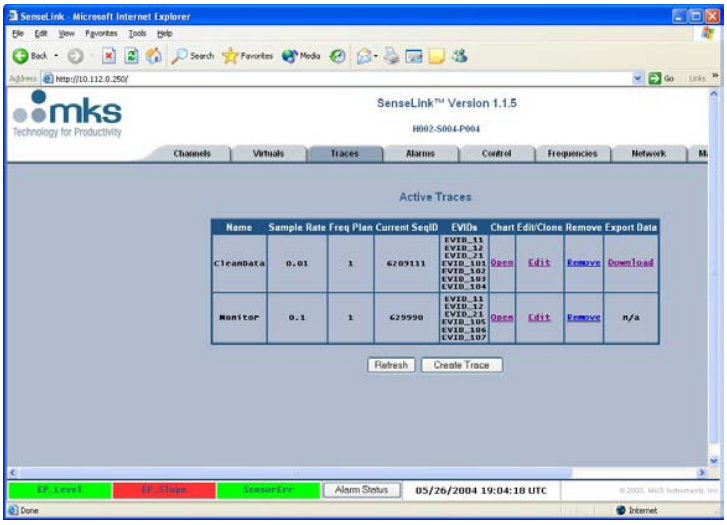
9. Next you should see the Trace Monitor Open revealing real time data.

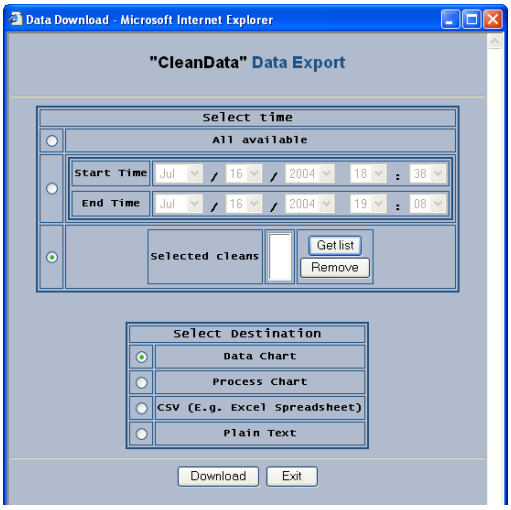


10. To manipulate the chart, there are several useful icons. The most common are:
    - Show names (provides the labels of each I/O)
    - Crosshair cursor (crosshair with exact value and time)
    - Show all (shows all data in the current collection, compresses time scale)

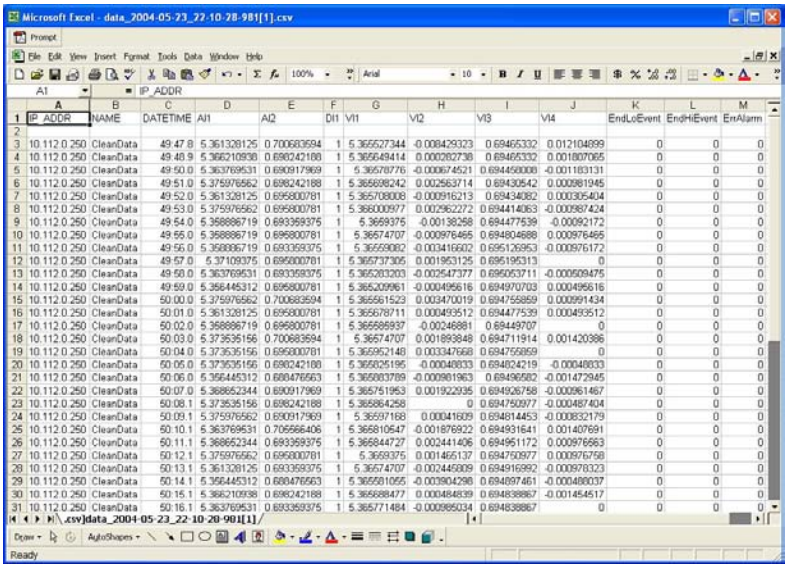


11. Transport the collected data to your PC. After a Clean, data will be stored. Under the Traces tab, for the CleanData plan, in the Download Data column, select 'Download'. A page will open to provide options on the timeframe of data you would like to access.





12. Click on 'Download' and the data will be sent to your PC, for MS-Excel viewing.



3 SenseLink™ End-Point Operation

On power-up, the RMU with SenseLink™ End-Point Control will automatically begin running its control state machine for end-point detection. The unit is monitoring all specified sensor signals and waiting for serial commands from the Tool Module Controller to begin detection.

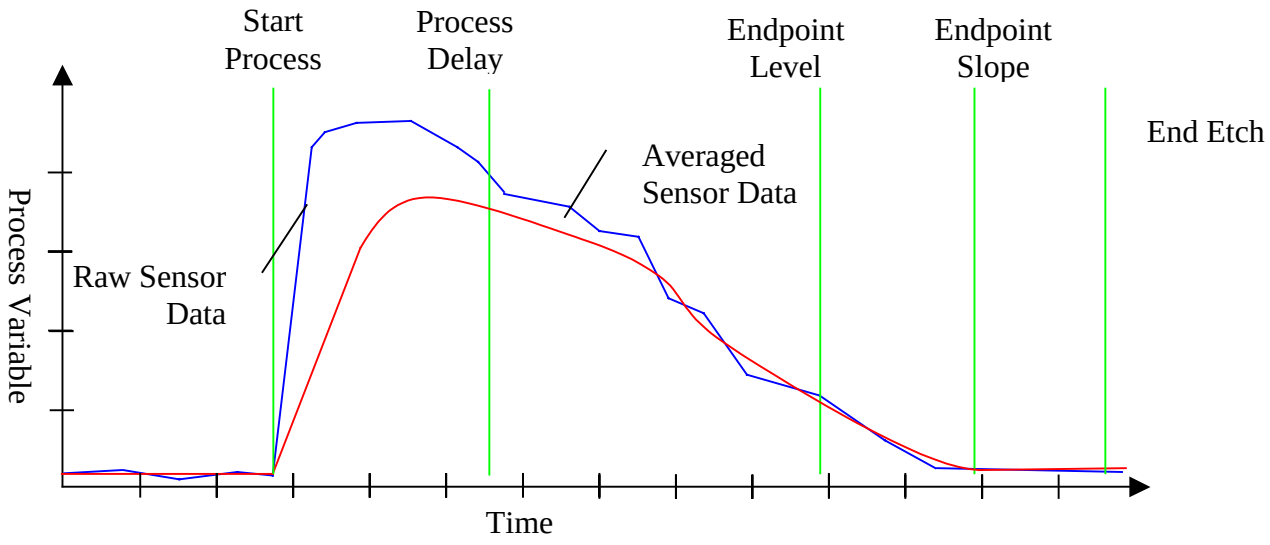
There are 4 processes running in the SenseLink™ environment, in a multi-tasked method:

1. End-Point control process state machine
2. Data acquisition
3. Data logging
4. Alarm logic

Processes #2 - #4 are part of the standard SenseLink™ architecture, and are described in the SenseLink™ Users Manual. Process #1 is defined in this addendum, as this task is application specific.

3.1 State Machine Functionality

The Process State Machine runs in parallel with the data acquisition, data logging, and alarm monitoring. The following Graph shows a typical process feedback and the interaction with the End-Point logic states:

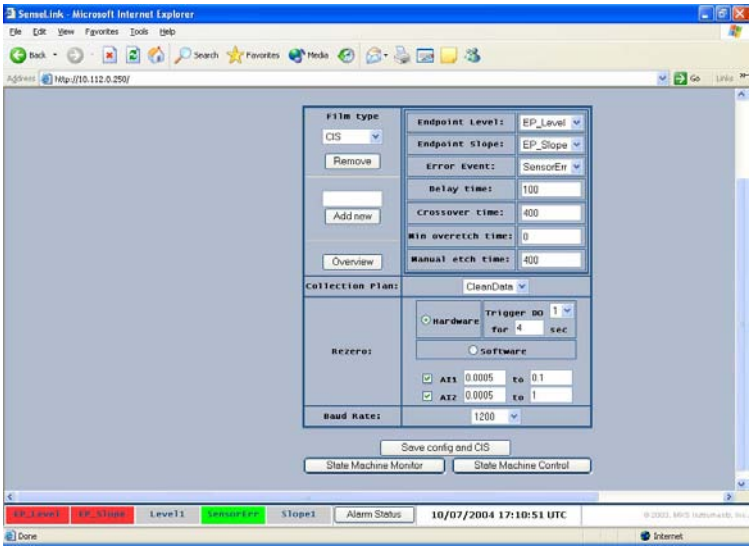


3.2 SenseLink™ End-Point Configuration

The end-point configuration uses the standard SenseLink™ application with the addition of an application specific Control tab. The control functionality used in conjunction with a properly configured SenseLink™ application performs End-Point control and tool communication.

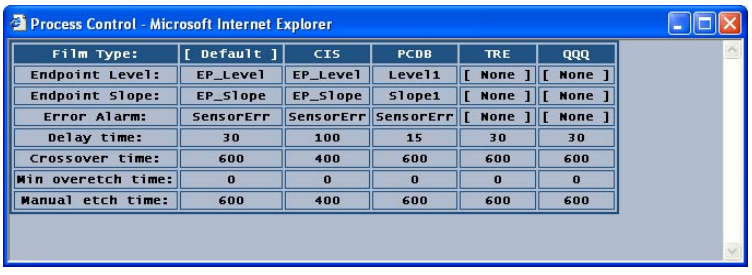
3.3 Control

The Following Screen shot is for Control Tab settings. It uses the Inputs from several analog, digital, and virtual inputs to create the logic for End-Point control.



Film Type – Allows the definition of End-Point “Recipes” or multiple setups that store all of the parameters for End-Point under a Film Type name, and utilize these when the Start command specifies this Film Type.

Film Type Overview – provides a comparison chart of all Film Type parameters



Film Type:	[Default]	CIS	PCDB	TRE	QQQ
Endpoint Level:	EP_Level	EP_Level	Level1	[None]	[None]
Endpoint Slope:	EP_Slope	EP_Slope	Slope1	[None]	[None]
Error Alarm:	SensorErr	SensorErr	SensorErr	[None]	[None]
Delay time:	30	100	15	30	30
Crossover time:	600	400	600	600	600
Min overetch time:	0	0	0	0	0
Manual etch time:	600	400	600	600	600

Endpoint Level – is an alarm used to transition the state machine into the Monitor Slope State.

Endpoint Slope - is an alarm used to transition the state machine into the Over-Etch State.

Error Event – is an alarm used to determine if a sensor error has occurred. This is a digital input from the Process Sense controller. An Active Low ON signal indicates the Process Sense is OK. Absence of this signal indicates a Fault condition.

Collection Plan – is used to determine which collection plan will be used in the Control Process. This is the data stored during the End-Point control process.

Delay Time – The Delay Time is used to delay the start of the Endpoint Monitor state of the state machine. This allows the process to stabilize before the End-Point algorithms are activated.

Crossover Time – a timeout parameter. Maximum time that can be spent waiting for an Endpoint Level event. If crossover time expires, control moves to the next state, Endpoint Slope.

Min Overetch Time – is the minimum over-etch time from the detection of Endpoint Slope. Actual over-etch time is calculated as a % of total time elapsed from the Start command to beginning of Over-Etch state. The % is passed in the Start command, from the Tool controller.

Manual Etch Time – is used the set a manually timed Clean, if the state machine is bypassed.

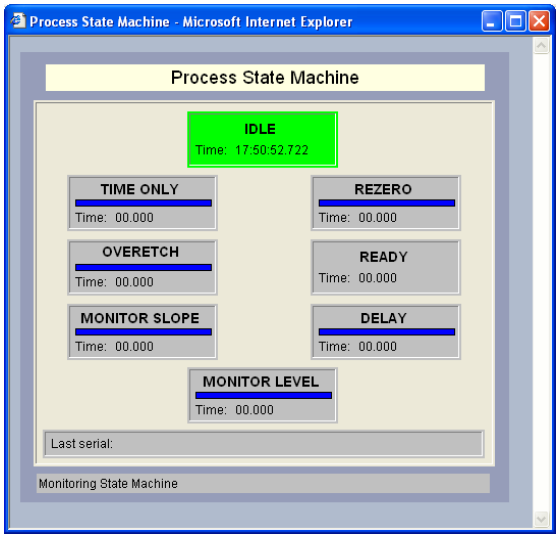
Baud Rate – is used to set the baud rate for the RS232 port used for tool controller communication.

Rezero - is used to set up the re-zero process for the input sensor. It can be set up for a software or a hardware process. Hardware re-zero of a Process Sense requires an Active Low signal for a 3 second duration.

Rezero Limits – If checked as active, these limits will be used to test the value of the sensor signal after a re-zero is complete. If the sensor signal does not fall within this range, an Error notification is sent to the Tool Controller. End-Point Controller is reset to the Idle state.

3.4 State Machine Monitor

Provides visual indication of the state of the End-Point Controller



Idle – Process State Machine is waiting to begin. Actual Process Sense data can be viewed using the Monitor collection plan, but is not stored.

ReZero – Process State in which the analog sensor is calibrated to a new zero point.

Ready – Process State Machine has calibrated sensor and is waiting for a Start command from the Tool controller.

Delay – Process State that uses the Minimum Delay to allow the process to stabilize, before beginning End-Point control algorithms.

Monitor Level – Process State that monitors Endpoint Level.

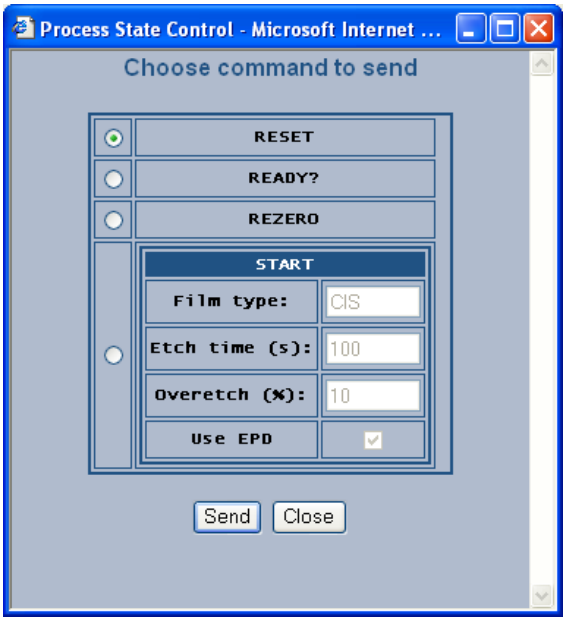
Monitor Slope - Process State that monitors Endpoint Slope.

Overetch – Timed state to allow additional Clean time. Actual over-etch time is calculated as a % of total time elapsed from the Start command to beginning of Over-Etch state. The % is passed in the Start command, from the Tool controller.

Time Only – Process State which can provide a manually timed Clean. Used when all End-Point algorithms are bypassed.

3.5 State Machine Control

State Machine Control is a simulation aid, to run End-Point process through a direct user interface, rather than Tool Control via the Serial Communication port. This function runs in parallel to the Serial port commands from the Tool controller.



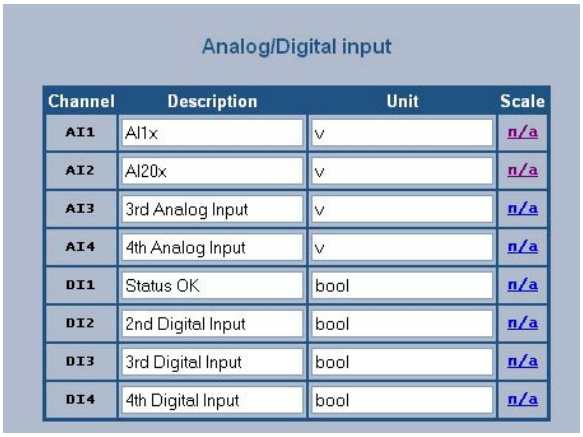
To simulate a command, select the action and then click on Send. Details for each command are found in section 4, Tool Controller Communication.

3.6 Process Parameters

All of the logic parameters are setup in the data acquisition and alarm sections of the SenseLink™ environment. Reference the SenseLink™ Manual for a complete description. The main parameters used for End-Point detection are summarized here.

3.6.1 Process Sense Inputs

AI1X and AI20X are the main sensor inputs coming from the Process Sense. These are located under the Channels tab, and can be scaled here. Default units are Volts.

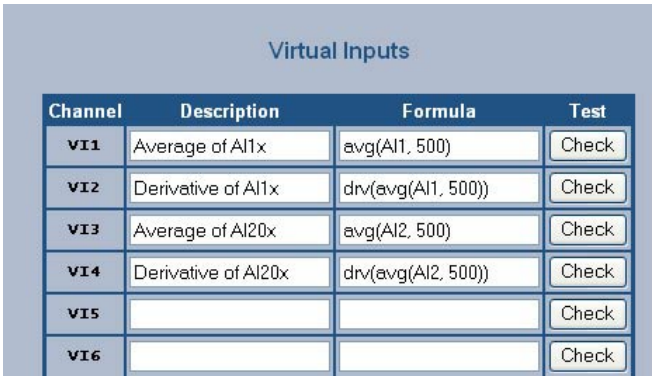


Analog/Digital input

Channel	Description	Unit	Scale
AI1	AI1x	v	n/a
AI2	AI20x	v	n/a
AI3	3rd Analog Input	v	n/a
AI4	4th Analog Input	v	n/a
DI1	Status OK	bool	n/a
DI2	2nd Digital Input	bool	n/a
DI3	3rd Digital Input	bool	n/a
DI4	4th Digital Input	bool	n/a

3.6.2 Virtual Inputs

Virtual inputs are variables which result from functions. For End-Point control, Average and Derivative are the common functions which are traced and collected.

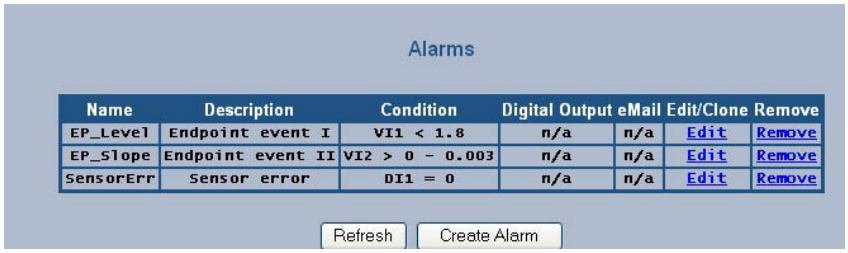


Virtual Inputs

Channel	Description	Formula	Test
VI1	Average of AI1x	avg(AI1, 500)	Check
VI2	Derivative of AI1x	drv(avg(AI1, 500))	Check
VI3	Average of AI20x	avg(AI2, 500)	Check
VI4	Derivative of AI20x	drv(avg(AI2, 500))	Check
VI5			Check
VI6			Check

3.6.3 Alarms

Alarms are the conditions used to create the End-Point logic. By default, one is used for level, the other for slope. The logic, however, is completely open to the User. A complete list of operations is located in the SenseLink™ Manual.



Alarms

Name	Description	Condition	Digital Output	eMail	Edit/Clone	Remove
EP_Level	Endpoint event I	VI1 < 1.8	n/a	n/a	Edit	Remove
EP_Slope	Endpoint event II	VI2 > 0 - 0.003	n/a	n/a	Edit	Remove
SensorErr	Sensor error	DI1 = 0	n/a	n/a	Edit	Remove

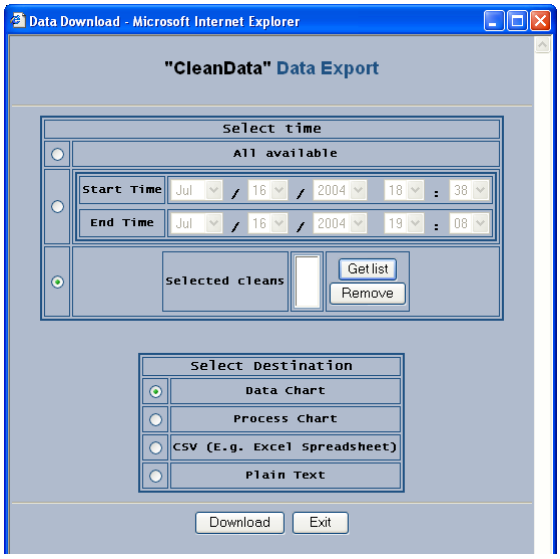
Refresh Create Alarm

3.7 Data Export

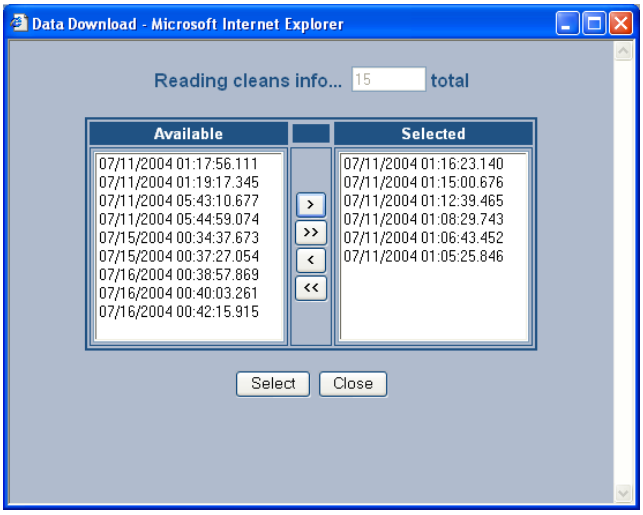
Data stored in the RMU is available for export in several formats. Most of these are described in the SenseLink™ Manual. An additional format is provided exclusively for End-Point Control.

The data for each Clean cycle can be selected individually for download.

From the Traces tab, go to the Clean Data collection plan, and Click on Download Data.



Click on Get List, and All cleans available will be shown. Select those you want for download, and click Select. The Window will close, and you choose which destination (usually CSV - MS Excel), and Click on Download.



4 Tool Controller Communication

The communication between each Tool controller and the RMU will carried over a dedicated serial communicating line (RS-232 line levels). The RMU will use its COM3 (/dev/ttyS1) port (/dev/ttyS0) for this purpose. Each connection will use a DB-9 type connector with RX, TX, and GND lines.

4.1 Serial Communication Parameters

The following defaults communication parameters will be set at the RMU.

Parameter	Value
Baud Rate	1200
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

4.2 Message Structure

The message content will comprise of ASCII byte streams of variable length, based upon the message type. The following special characters will have special meaning.

Character	ASCII Code	Description
SPACE	0x20	Separates several parameters in a message
:	0x3a	Indicates a value assigned to a parameter
<CR>	0x0d	Indicates the end of a message

4.3 Message Format

The following table summaries the different messages between the Tool Controller and RMU (EPDI). Message details will be described in details in the following paragraphs.

Message	From	To	Description
RESET	Tool	RMU	Reset command
READY?	Tool	RMU	Ready command
READY	RMU	Tool	Ready response
REZERO	Tool	RMU	Rezero command

Message	From	To	Description
START	Tool	RMU	Start monitoring command
ENDP <C>	RMU	Tool	End Point Event
EPOE	RMU	Tool	End of Over Etch event
EPERR	RMU	Tool	EPDI Error message

The following describes in details the message format for each request and command. The flowing notation will be used:

<D>	Indicates a single alphanumeric character (0-9).
<DD>	Indicates two alphanumeric characters (example: 123)
<FF.FF>	Indicates a floating point number (for example 3.62, -0.45)
<SSSSSS>	Indicates a variable length character string.
<C>	Indicates one Character
<CR>	Indicates end of message (carriage return)

4.3.1 Reset Command

Purpose	Force the EPDI into the IDLE state
Message Format	RESET<CR>
Response	None
Example	RESET<CR>

4.3.2 Ready Command

Purpose	Check for presence of the EPDI system; prepare the EPDI (perform re-zero operation from an Idle State).
Message Format	READY?<CR>
Response	Ready Response if re-zero was finished OK, Error Response if sensor's fault bit was set during operation.
Example	READY?<CR>

4.3.3 Ready Response

Purpose	EPDI response to Ready Command (when no error detected)
Message Format	READY<CR>
Response	None
Example	READY<CR>

4.3.4 Rezero Command

Purpose	IF in Ready or Idle State, triggers a Re-zero function. The method of Re-zero is defined by the parameters from the Control tab, and will be either a s/w or h/w re-zero. If Re-zero Limits are enabled, these will be checked at the end of the Re-zero function.
Message Format	REZERO<CR>
Response	Error Response if limit test failed or Sensors fault bit was set.
Example	REZERO<CR>

4.3.5 Start Command

Purpose	This command sends all required configuration parameters to the EPDI and instructs it to start monitoring. The message will provide the EPDI with the following 6 configuration data (all of them are mandatory): **N:** Parameter count. Always 6 **'fTyp':** Film type (string) **'dpos':** Film thickness (angstroms, integer) **'echT':** Estimated Etch time (seconds, integer). **'ovet':** Over-Etch time (% of echT, integer). **'batch':** Batch size (integer). **'mode' or 'EPD':** Endpoint mode (0 = timed, 1 = Use EPD algorithm)
Message Format	START N param1:data1 param2:data2 … paramN:dataN<CR>
Response	None
Example	START 6 fTyp:XXX dpos:100 echT:40 ovet:7 batch:10 EPD:1<CR>

The following describes the possible values to the mode/EPD parameter:

Algorithm Type	Value	Description
Timed	0	Use the time value in the configuration

		database to determine end-point. No Over Etch will be calculated
Algorithm	1	Perform detection according to more (Level, Slope, Conditional). Also, performs Over Etch detection per 'ovet' parameter.

4.3.6 End-Point Event

Purpose EPDI has detected the End Point event. Several types of Endpoint events can be reported:

- **ENDP L**: Level Endpoint event (for Level and first step of Conditional detection)
- **ENDP S**: Slope Endpoint event (for Slope and second step of Conditional detection)
- **ENDP F**: For Conditional detection, when Crossover Timer expires before a Level Endpoint event detected.

Message Format `ENDP <C><CR>`

Response None

Example `ENDP L<CR>`

4.3.7 End of Over Etch Event

Purpose EPDI has detected that the over-etch time has expired

Message Format `EPOE<CR>`

Response None

Example `EPOE<CR>`

4.3.8 Manual Timed End-Point Event

Purpose EPDI is running in Manual Timed mode. Time has expired.

Message Format `ENDP<CR>`

Response None

Example `ENDP<CR>`

4.3.9 EPDI Error

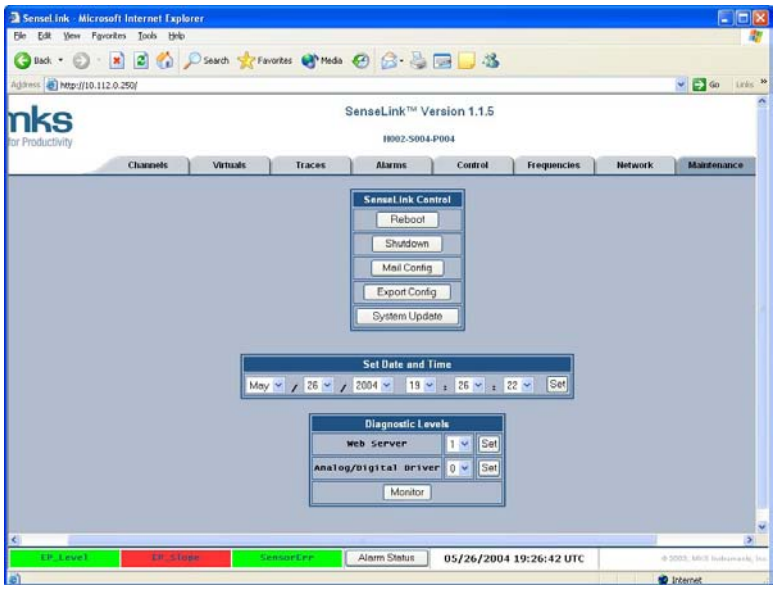
Purpose	EPDI has detected errors during its operation (in any of its states, per the state diagram)
Message Format	EPERR<CR>
Response	None
Example	EPERR<CR>

5 System Maintenance

5.1 Import / Export a Configuration

Once an End-Point configuration is complete, save the configuration by clicking on the **Export Config** function. This will allow you to name a file and save it on your local machine.

To duplicate this configuration on another RMU, simply import this same file using the System Update function.



5.2 Set Time

Change the base time using the **Set Date and Time** function under the Maintenance tab (above). There is also the capability to synchronize to a network based time server. This function resides under the Network tab.

6 Notes